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GB 2304077 A EP 0570162 A2 EP 0364029 A1
WO 91/19614 A1 US 4767205 A US 4218674 A

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UK CL (Edition O ) B6A ATC
INT CL[6] B42D 15/00 15/10 , G06K 19/06 19/14 , G07F 7/08
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(54) Abstract Title
**An identification code for banknotes or credit cards comprising a pattern of random beads**

(57) The code comprises a two- or three-dimensional plastic matrix 3 having embedded therein randomly-positioned visually distinguishable beads 5. The position of the beads is read and recorded as an identification code, eg by recording the position of a sequence of beads above or below a line representative of the ones and zeros in a binary code. The binary code can be read and stored in a database as an identifier of the banknote. Two or more codes may be used, one hidden and one visible, with both codes being recorded.

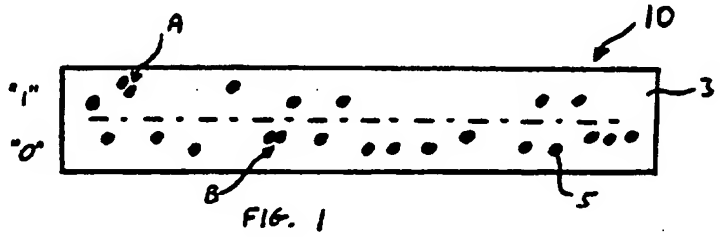


FIG. 1

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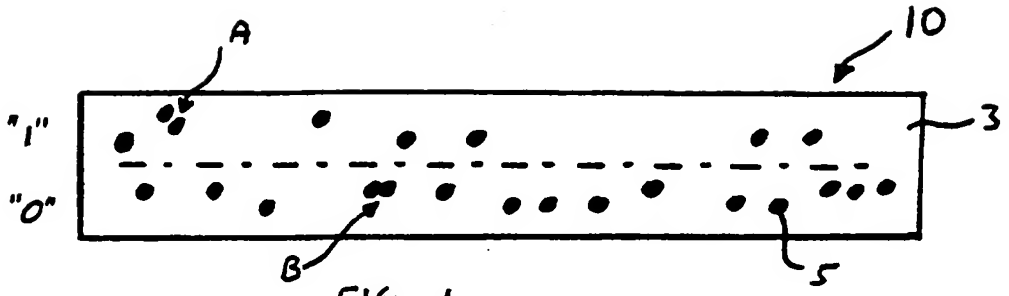



FIG. 1

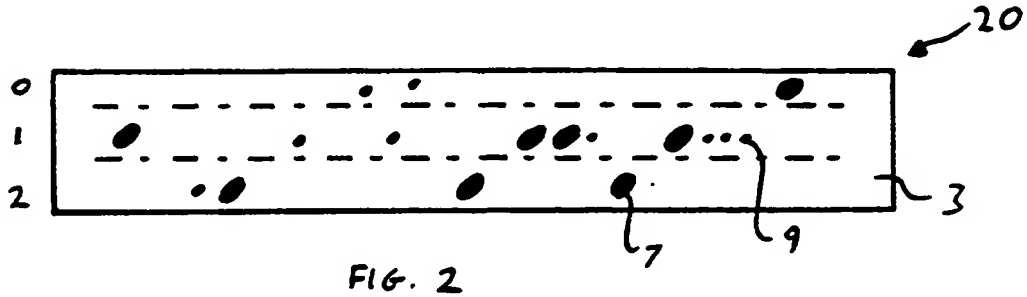



FIG. 2

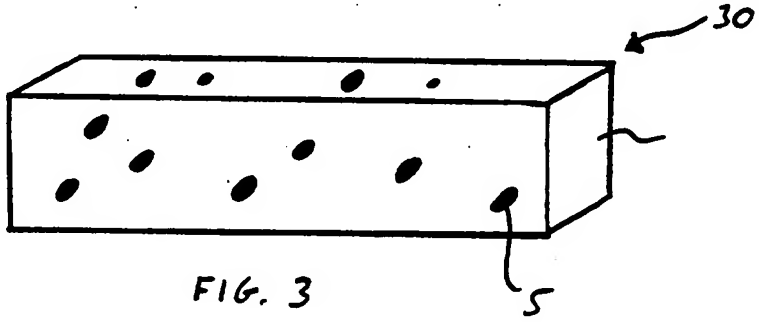



FIG. 3

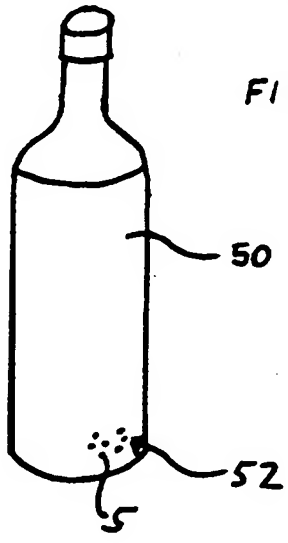
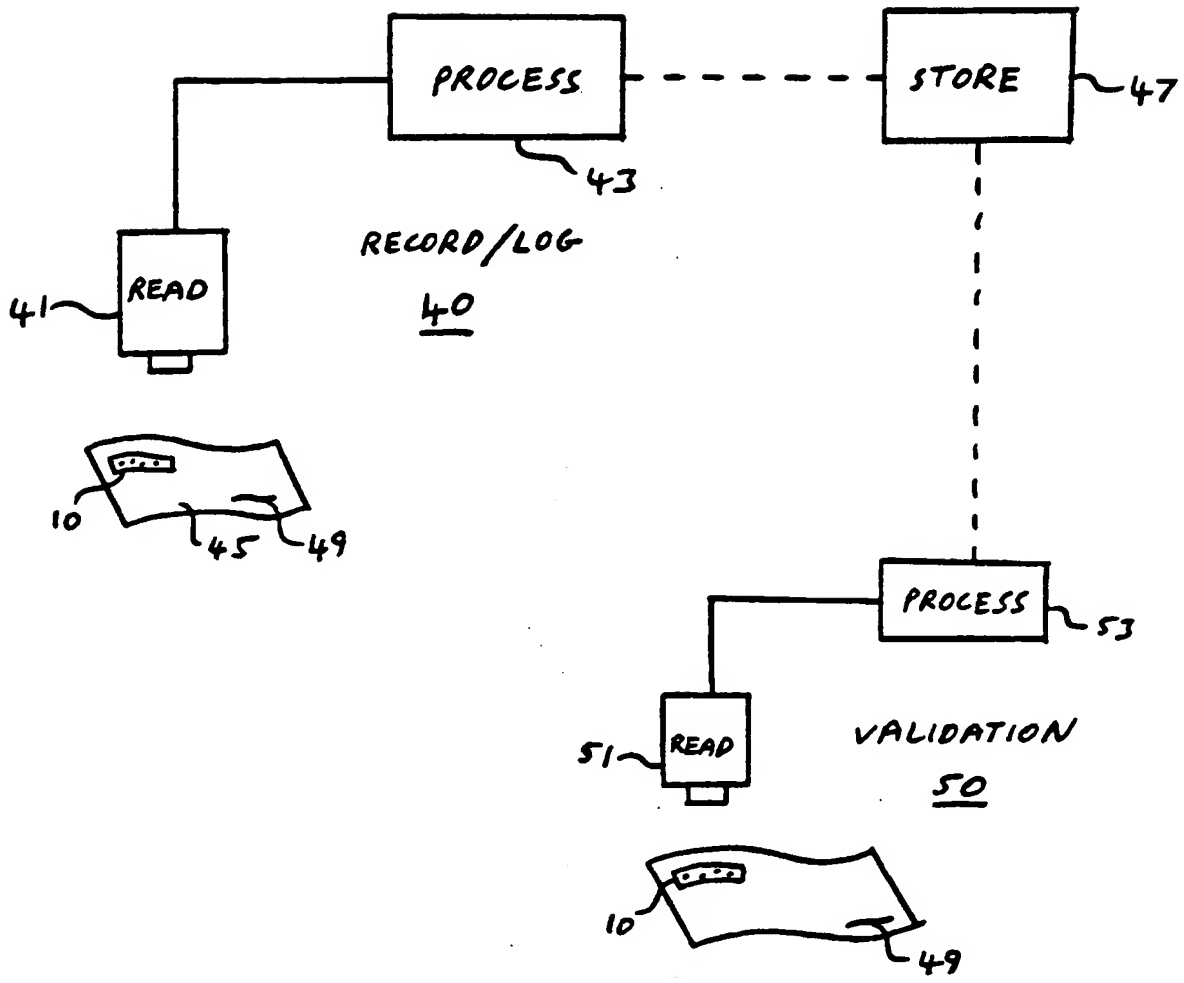



FIG. 5

FIG. 4


PROCESS
STORE
47
43
RECORD/LOG
40
READ
41
10
45
49
PROCESS
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READ
51
VALIDATION
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10
49

# IDENTIFICATION LABEL AND METHOD OF LABELLING AN OBJECT

The invention relates to an identification label, which can be used, for instance, as a security tag, or be incorporated into a product, and to a method of making the label and labelling objects using the label.

A variety of methods of security marking of objects have been proposed or are currently in use. For instance, objects can carry one or more labels overtly or covertly provided (or both) which carry a code identifying the object. That code is stored in a database. The label can carry the code in the form of printed numbers or barcodes, DNA or specific antibodies, or various electronic methods such as microchips, etc. The disadvantage with these type of systems is that once one knows the identification code, it is relatively easy to reproduce identical identifying labels.

It is also known for preventing counterfeiting to provide objects such as banknotes or credit notes with parts which are difficult to reproduce. The notes can use patterns which use special colours or resolutions, or can carry holographic labels.

It is an object of the present invention to provide an improved identifier label and labelling system in which it is very difficult, to the extent of being practically impossible, to reproduce the label, even given the knowledge of the identification code which it carries, and therefore to provide an uncounterfeitable unique label.

Accordingly, the present invention provides a unique tag or label which is based on random physical

discontinuities which can be incorporated into or onto the item to be uniquely labelled.

For instance, the invention can provide a label carrying an identification code, the label comprising first and second mutually distinguishable components, the second component being fixedly- and randomly-distributed non-uniformly with respect to the first, the position of the second component forming the identification code of the label.

The second component may be distinguishable from the first optically or in other ways, e.g. by being magnetic, radioactive, or giving a change in conductance, resistance or inductance. The requirement is that the two components are heterogeneous after the label has completed manufacture and are measurably distinguishable.

The first component can be a matrix which can be of solidified plastic or resin. The second component can be a plurality of code elements, for instance beads/particles of the same or different sizes, fixed within the matrix. There may be a multiplicity of beads and the beads may be visually distinguishable (e.g. by opacity, colour, refractive index or size) to allow reading of the label using an optical reader. The beads may be, for instance, of 10 to 100 μm in diameter and the label can be, for instance, less than 1 mm thick.

Instead of beads, bubbles could be used. They could contain a substance to facilitate a particular type of measurement, e.g. osmium salts for electron microscopy or barium salts for X-ray measurement.

Alternatively, the code elements could be incorporated into a liquid aerosol spray (e.g. lacquer)

sprayed onto a surface and as the spray dries the elements will be held in position. Variations in this technique such as brushing on, painting on, dipping, electrostatically attaching or making each element or the material sticky are also possible.

The position of the code elements within the matrix can be measured in two dimensions, for instance by noting their position above or below a line, as indicative of a binary code, or in three dimensions.

The matrix forming the first component can be the material of the article to be labelled. For instance, if a glass or plastic bottle is to be labelled, the second component, e.g. beads, could be mixed with the glass or plastic, but preferably in a defined region of the bottle. Clearly, other types of container or article can be labelled in this way, for instance: car windscreens, plastic, cellophane, the lacquer coating of packaging on a cardboard base etc.

The two components need not be beads in a matrix. For instance, they could be two distinguishable solidifiable liquids, e.g. two differently coloured resins. Incomplete mixing to produce a non-uniform mixture followed by formation into a label and solidification would give a unique pattern. The pattern could be stored by pattern recognition apparatus or a code generated e.g. by measuring the proportion of one component in given regions and designating proportions above 50% as a binary "1" and below 50% as a binary "0".

The invention also provides a method of manufacturing such a label, the method comprising providing the first and second components and adding them together to fixedly, randomly and non-uniformly distribute

the second component with respect to the first.

Thus, an almost infinite number of unique labels can easily be produced just by mixing and stirring the two components, e.g. the beads into the matrix (e.g. resin), then forming the mixture into the label. The mixture may be such that it can form a label itself, or be attached to a carrier to constitute a label, or incorporated as an integral part of the article.

The label can be used by identifying the position of the second component within the first, e.g. the elements within the matrix, and recording that position as an identifier of an object to be labelled. The label is then attached to the object. The code is stored in a database so that it is always possible to check the identity of the object by reading the label attached to it and checking it with the database. The object could also be provided with a serial number against which the identification code could be checked, or two labels according to the invention could be attached to an object, for instance one overtly and one covertly, and both codes recorded in the database.

An advantage of the invention is that even with knowledge of the code carried by the label, it is very difficult to produce a second label with that code. For instance, where beads are used it is very difficult to reproduce the exact random conditions which led to the particular dispersion of beads in the first place. It should be noted that with the invention, it is not a case of generating the identification code and then forming the label according to that code, but forming the label first, reading its code and then recording that code for the label and labelled object.

Other aspects of the invention provide a corresponding method of labelling an object and a system for reading, analysing and storing identifiers and collating subsequently read identities.

The invention will be further described by way of non-limitative example, with reference to the accompanying drawings, in which:-

Figure 1 diagrammatically illustrates a label according to a first embodiment of the invention;

Figure 2 diagrammatically illustrates a label according to a second embodiment of the invention;

Figure 3 diagrammatically illustrates a third embodiment of the invention;

Figure 4 diagrammatically illustrates a security/validation system according to the invention; and

Figure 5 diagrammatically illustrates an embodiment of the invention incorporated in a bottle.

As shown in Figure 1, the label 1 is composed of a matrix 3, typically of translucent plastic (e.g. acrylic polymer) which forms the body of the label. The body can be, for example, up to 1 mm thick. Embedded within the matrix are beads/particles 5 of predefined diameter (e.g. 10 $\mu$m polystyrene beads). These are incorporated in the matrix in a random, non-uniform distribution. This is achieved by first mixing a plurality of the beads with liquid matrix material, forming the mixture into the required shape of the label and then allowing the matrix to solidify. As the matrix solidifies, the beads are trapped and held in position. The plastic used is

preferably flexible when solidified.

In one example, the matrix can be formed, for instance, of an epoxy resin which is solidified by mixture with a setting agent.

The mixing process results in the random positioning of the beads. Thus, there is no requirement to physically "place" the beads in a given position. The random nature of the process generates a large number of unique labels.

Figure 2 shows a variation of the embodiment of Figure 1 in which beads 7 and 9 of different diameters (two in this case) are used in the label 20. This increases the number of variations achievable by a label containing a given number of beads. Different colours or other physical differences can be used.

An alternative way of producing the labels shown in Figures 1 and 2 is by incorporating the beads into a liquid to be painted, sprayed or brushed onto an object before solidifying. Or the beads, or the label or object could be made sticky so that they adhere on application. In a further alternative, the beads could be applied before being covered by a solidifying material to fix their position.

The code formed by the positioning of the beads can be read in a number of ways, using any number of a range of standard visual (or other) properties to record the position of the dispersed beads. For example, as shown in Figure 1, the distribution of the beads about a central line (which may or may not be marked on the label itself) can be recorded, with those above the line scored and recorded as a binary "1" and those below scored as a

binary "0". This can be done using a known image analysis system. Clearly, this generates a binary code for each label. The code for the label illustrated in Figure 1 would be 10100101010000010100O. Clearly, ensuring a sufficient number of codes is a matter of statistical choice which is dependent on the number of beads analysed over a given length or region of the label. It is clear that the maximum number of codes for n beads in a label read as illustrated in Figure 2 is $2^n=1.1x10^9$. 40 beads would yield $1.1x10^{12}$ combinations; 50 would provide $1.1x10^{15}$ combinations. Varying the sizes of the beads as shown in Figure 2 increases the number of combinations. Another possibility is to read the position of the beads in more detail than just above or below a centre line. For instance, it would be possible to read how many beads are in given zones or, as illustrated in Figure 2, to define two lines and read the beads as indicative of a 0, 1 or 2 in a system to give codes of base 3.

It should be noted that normally the software controlling the reading process is adapted to exclude difficult situations where beads overlap or touch as shown at A or B in Figure 1. It can also be adapted to exclude duplicate labels if they occur.

Figure 3 illustrates a further alternative version of the label. In Figures 1 and 2, the position of the beads was recorded essentially two dimensionally, i.e. along and vertically on the label. However, the label 30 could be given a significant depth as shown in Figure 3 and the position of the beads 5 in three dimensions measured and recorded. While this increases the number of codes, it also increases the image processing and software requirements.

It should be noted that the number of beads used should be sufficient to give a sufficient number of unique codes, but also not so great that the beads cannot be individually read. Too many beads could result in an essentially uniform distribution compared to the

resolution of the reading device. So, the number and size of beads should be chosen according to the required application. It is possible for the beads to be large enough to be read unaided, or small beads could be used and magnification incorporated into the reader. Clearly, the reader can be adapted to scan the labels (reader movement) or the labels can be scanned past fixed readers (label movement).

Of course, rather than translating the position of the beads into codes, it would be possible to use standard image analysis or image grabbing systems with a predetermined definition together with pattern recognition systems. Then it would be the overall pattern which is recorded, the number of codes being dependent on the number of beads and the resolution of the pattern recognition system.

The physical size and shape of the label depends on the required application. For instance, for use in banknotes, the label could be similar in size to the familiar "metal" strip and could be incorporated into the notes at the time of note manufacture. Alternatively, the tag could be incorporated into a plastic window set in the note, as recently introduced in Australia, for displaying a hologram. The label could be configured to be incorporated into a credit card. Thus, the size of the label and of the beads would normally be considerably smaller than that illustrated in Figures 1, 2 or 3.

The label can be incorporated as an integral part of the object to be labelled. For instance, Figure 5 schematically shows a bottle 50 in a defined region 52 of which the beads 5 are incorporated just as in Figures 1 to 3 but with the matrix being the material of the bottle, e.g. glass. Clearly, the beads are chosen to survive the

manufacturing process, e.g. to withstand the temperature of molten glass.

When the label is used for identifying banknotes there is no need to read the label at the time of banknote manufacture. This can be deferred until public release of the banknote as described below.

Figure 4 diagrammatically illustrates a security/validation system using the invention as applied to an article such as a banknote. The system includes a recording/logging part 40 which includes a reader 41 and processor 43. When the banknote 45 is ready to be released to the public, the label 10 is read by the reader 41 and the code is analysed by the processor 43 and logged in the store 47. As one example, the code can be logged together with the serial or batch number 49 of the banknote.

Thus, the recording/logging part would just be used once for initial logging of the label code. The store 47 is preferably a secure, centralised database.

If, after the banknote has been released, it is desired to check the validity of the note, the label 10 is read by the reader 51, the code calculated by processor 53 (which is analogous to processor 43) and compared with the code and serial number 49 stored in store 47. The validation process of comparing the code and serial number can occur either in the processor at the validation station, or at the store 47. For instance, the processor 53 can send the code and serial number to the store 47 which checks them against the stored numbers and sends back a positive or negative response to confirm authenticity.

Thus this makes it possible to read a unique, uncounterfeitable label or coded region in a product directly in real time (in a matter of seconds or minutes depending on the nature of the reader and checking system) to give an immediate validation answer. Thus, it is capable of being an immediate detection system for counterfeited items.

In an alternative application of the invention, the manufacturer of the identification labels 10,20,30 could read and log the code on each label together with a serial number of the label (the serial number also being printed on the label) and then a supply of labels could be sent to the end user of them. Such labels could then be used to label objects which the end user wants to monitor. The end user can be provided with a validation unit 50 so that they can check the authenticity of any labelled object as desired.

In a variation, two or more labels according to the invention can be applied to an object and both codes recorded in store 47. One label could be overt and one covert (i.e. hidden). This could give an increased degree of security.

## C L A I M S

1. A label carrying an identification code, the label comprising first and second mutually distinguishable components, the second component being fixedly- and randomly-distributed non-uniformly with respect to the first, the position of the second component forming the identification code of the label.

2. A label according to claim 1, wherein the first component is a solid matrix and the second is a plurality of code elements.

3. A label according to claim 2, wherein the matrix holds the code elements fixed within it.

4. A label according to claim 2 or 3, wherein there are a multiplicity of code elements.

5. A label according to claim 2, 3 or 4, wherein the code elements are all of substantially the same size.

6. A label according to claim 2, 3 or 4, wherein there are a plurality of different sized code elements.

7. A label according to any one of claims 2 to 6, wherein the position of the code elements above or below a line is indicative of a binary identification code.

8. A label according to any one of claims 2 to 6, wherein the position in three-dimensions of the code elements within the matrix is indicative of the identification code.

9. A label according to any one of claims 2 to 8, wherein the code elements are beads.

10. A label according to claim 9, wherein the size of the beads is in the range 10 to 100 μm.

11. A label according to any one of claims 2 to 10, wherein the matrix is solidified plastic.

12. A label according to any one of claims 2 to 11, wherein the matrix is in the form of a flat sheet having a thickness less than 1 mm.

13. A label according to any one of the preceding claims, wherein the second component is visually distinguishable from the first.

14. A method of manufacturing a label of the form claimed in any one of claims 1 to 13, the method comprising providing the first and second components and adding them together to fixedly, randomly and non-uniformly distribute the second component with respect to the first.

15. A method according to claim 14, wherein the first component is a solidifiable fluid, and the second is a plurality of code elements, the solidified fluid forming a matrix for the code elements.

16. A method according to claim 15, wherein the solidifiable fluid is a solidifiable plastics material.

17. A method according to claim 16, wherein the solidifiable plastics material is a resin.

18. A method according to claim 15, 16 or 17, wherein the code elements are beads of the same or different sizes.

19. A method according to any one of claims 14 to 18, further comprising recording the position of the second component as the identification code.

20. A method of labelling an object comprising the steps of selecting a label according to any one of claims 1 to 13, or made according to any one of claims 14 to 19, identifying the position of the second component in the first and recording that position as an identifier of the object, and attaching the label to the object.

21. A method according to claim 20, wherein the step of identifying the position of the elements comprises identifying the position of the elements above or below a line as representative of a binary code.

22. A method according to claim 20 or 21, comprising the step of attaching two labels to the object, one visible and one hidden, and recording the position of the elements on both of the labels as identifiers of the object.

23. A method of labelling an object using a label according to any one of claims 1 to 13, by incorporating the label integrally with the object, the first component being a component of the object, the position of the second component in the first being identified and recorded as an identifier of the object.

24. A method according to claim 23, wherein the second component is distributed in a predefined region of the object.

25. A label constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

26. A method of making a label substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

27. A method of labelling an object substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

28. An identification system for using the label of any one of claims 1 to 13 or 25, or a label made according to any one of claims 14 to 19 or 26, or an object labelled according to any one of claims 20 to 24 or 27, the system comprising a reader for reading the label, an analyser for identifying positions of the second component in the first as an identifier of that label, a store for storing the identifier, and a collator for comparing the identifiers of any subsequently read labels with stored identifiers and issuing a signal indicative of the result of the comparison.

Patent Office

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**Application No:** GB 9707183.1
**Claims searched:** 1-28

**Examiner:** Graham Russell
**Date of search:** 19 May 1997

# Patents Act 1977
# Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B6A (ATC)

Int Cl (Ed.6): B42D 15/00, 15/10; G06K19/06, 19/14; G07F 7/08

Other: Online: WPI

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| X | GB 2304077 A | (FARRALL) see page 2 lines 13-23; page 12 line 15 & page 13 lines 1-22 | 1-4, 8-11, 14-20, 23,24,28 |
| X | EP 0570162 A2 | (CANON) see column 3 line 20 - column 5 line 17 | 1-4,14, 20,28 |
| X | EP 0364029 A1 | (HOMER) see column 5 lines 19-33 | 1-5,9, 11,12, 14-20,28 |
| X | WO 91/19614 A1 | (TEL-DEVELOPMENTS) see page 7 lines 7-27 | 1-4,14, 20,28 |
| X | US 4767205 | (FLOW CYTOMETRY) see column 5 lines 13-17 | 1-4,6, 9-12, 14-20 |
| X | US 4218674 | (DASY) see column 7 lines 8-26 | 1-4,14, 20,28 |

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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